NATIONAL

HRO-500

SOLID STATE HF/VLF COMMUNICATIONS RECEIVER

The National Radio Company HRO-500 is a completely solid state communications receiver with a frequency range greater than that of any other unit available today. All facilities are incorporated for AM, CW, and SSB reception between five kilocycles and 30 megacycles, with unusually accurate dial calibration, high frequency stability, and ease of operation. The HRO-500 is currently in use by every major government agency in the United States for HF/VLF point-to-point communications, monitoring, and for laboratory instrumentation applications, and has rapidly become accepted as the finest and most versatile commercial receiver available for such use.

Complete transistorization provides a very high MTBF, together with minimal heat generation and power requirements, and allows the HRO-500 to be used in portable or field applications barred to existing vacuum tube equipment. Ease of operation, accuracy of dial calibration, short and long-term stability and sensitivity are demonstrably superior to competitive tube equipment, and offer a performance combination unequalled by any other commercial receiver.

The HRO-500 is remarkably compact in size and weight, and may be either table or rack mounted. In addition, a fully portable version is available with self-contained power, loudspeaker, and waterproof carrying case.

SUPERIOR FEATURES OF THE HRO-500 RECEIVER

☐ Complete coverage of the entire VLF/HF spectrum between five kilocycles and 30 Mc., with the same superb dial calibration, stability, and tuning rate throughout.

☐ Total transistorization for maximum reliability and versatility with minimum heat generation and power requirements.

☐ MTBF per NAV-SHIPS 93820 of 3820 hours results from conservative circuit design and proper de-rating of all components.

☐ Operates (with no need for accessory supplies) from 117/234 V.A.C. or 11-16 V.D.C. sources. Current drain at 12.6 V.D.C. only 200 ma.

☐ Complete SSB, AM, MCW, and CW facilities, including both product and diode detectors; *Passband Tuning* of filter for true selectable sideband reception; fast attack, slow decay AGC; and four discrete bandwidths from 500 cps to 8 Kc.

☐ Dial calibration accurate to one kilocycle over the entire frequency range, with bandspread of ¼″ per kilocycle and 24 feet per megacycle.

☐ Selectable tuning ratio of either 10 Kc or 50 Kc per revolution of main tuning control for choice of rapid band-scanning or fine tuning at will.

☐ "Instant-on" operation with no warm-up period required.

☐ Superb short and long term stability — nominal stability, including ±27% change in A.C. input voltage, better than 100 cps per day and 15 cps per °C.

☐ Frequency determination by means of phase-locked crystal frequency synthesizer assures maximum stability and elimination of band-to-band recalibration.

☐ Sensitivity and image rejection (averages 80 db, minimum 50 db) superior to the previous standard of comparison — the earlier HRO receivers.

☐ Unusually high dynamic range and resistance to cross modulation.

☐ Complete remote control provisions including AF and RF gain, BFO on-off, receiver mute, and power on-off.

☐ All necessary oscillator, AGC, I.F. and detector outputs provided for use with accessory equipment.

☐ Unusually flat audio response — 100 cps to 5500 cps within 6 db, with over 2 watts of available audio output.

☐ May be either table or rack-mounted (with accessory RMK-5 rack mounting kit).

☐ Compact size and light weight — 7⅝″ H, 16½″ W, 12¾″ D. Weight only 32 lbs.

☐ Available in completely portable configuration with self-contained rechargeable battery power, built-in loudspeaker, and luggage-type waterproof carrying case.

TOTAL SOLID STATE DESIGN

The National HRO-500 has rapidly been accepted as the finest commercial receiver available to government and industrial organizations — and some of the reasons why the HRO-500 is the standard of comparison are the following unique advantages resulting from total solid state design:

☐ Vastly improved reliability as compared with vacuum tube receivers of lesser sophistication. Calculated MTBF per NAVSHIPS 93820 is 3820 hours.

☐ Extremely low power drain and ability to operate from diversified power sources without external voltage converters. Current drain (with pilot lamps switched off) is only 200 ma. at 12 V.D.C. input, and the HRO-500 may also be operated directly from 117/234 V.A.C. sources.

☐ Miniscule heat generation in applications where multiple equipment is necessary or cooling is difficult. The greatest source of internal heat in the HRO-500 is the pilot lamp string (which may be switched off).

☐ Elimination of gradual performance deterioration resulting from tube "aging".

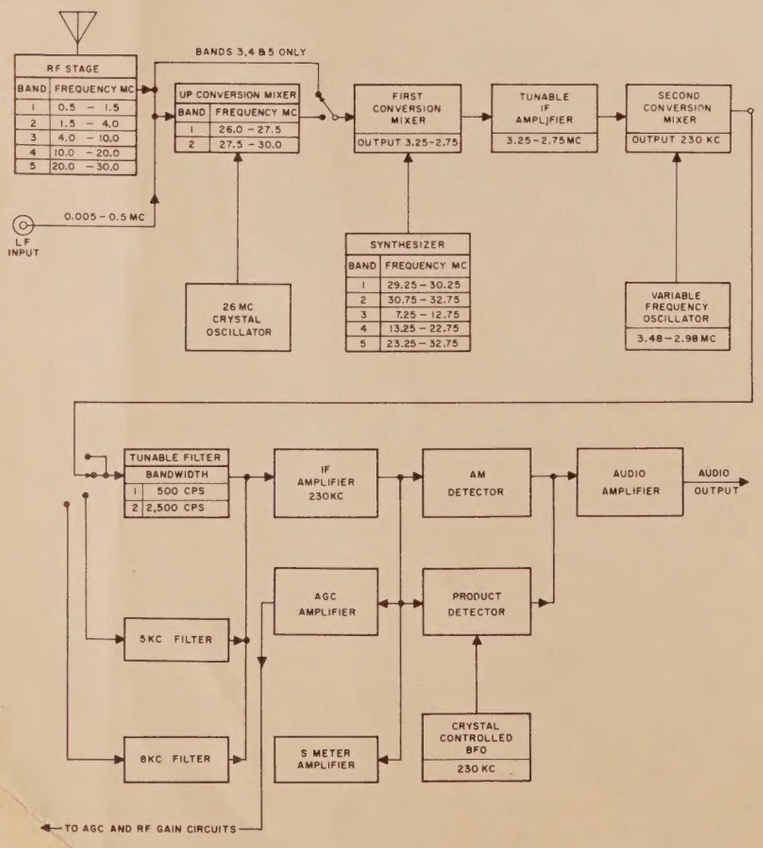
☐ "Instant-on" operation from turn-on without wait for warm-up.

☐ Greater initial stability from turn-on because the long term warm-up drift characteristics of tube-type oscillators (resulting from expansion of tube element structures with heat) is eliminated. Transistor junction temperatures are stabilized within two minutes.

☐ Low transistor element voltages permit triple electronic regulation during A.C. operation. Consequently, there is essentially no frequency shift over a ±27% variation in A.C. input voltage.

☐ Power input may be instantly switched from A.C. source to battery source in critical applications where loss of signal resulting from loss of A.C. power is unacceptable.

☐ Compact size, light weight, and low power drain permit fully portable HRO-500P configuration for field or transportable applications.

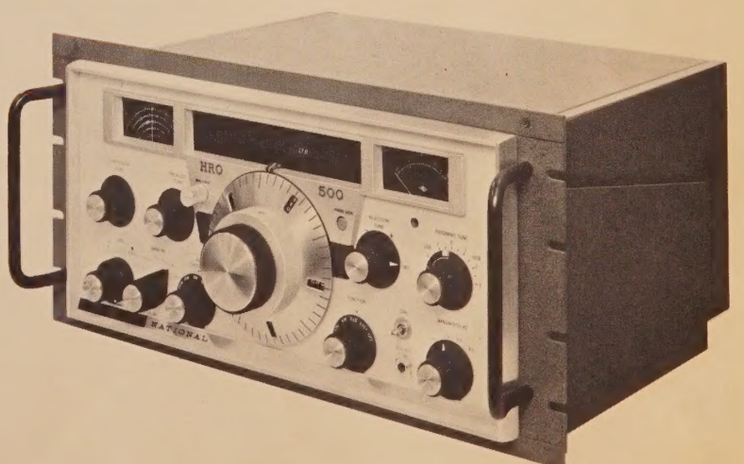


HRO-500 PHASE-LOCKED CRYSTAL FREQUENCY SYNTHESIZER

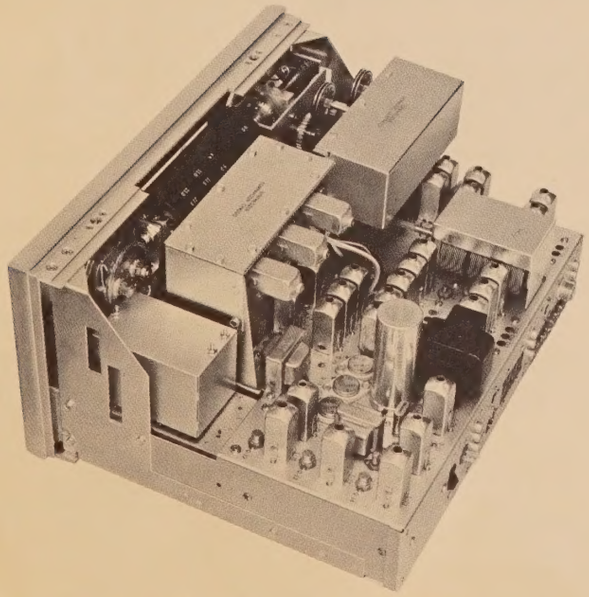
In order to achieve high stability and equal tuning rates, better conventional receivers employ separate crystal-controlled high frequency oscillators to mix incoming signals to the same tunable IF range; where they are again mixed with the output of a VFO (interpolation oscillator) to produce a fixed IF. The number of HFO crystals required is dependent upon the desired overall frequency range of the receiver and the tuning range of the VFO. If a conventional receiver existed with the five KC-30 Mc. range of the HRO-500, using, as does the HRO-500, a VFO with a range of 500 KC, up to 60 crystals would be required in the HFO. Besides the obvious expense of such a multiplicity of crystals, their use results in indeterminate band-to-band calibration and unpredictable overall stability.

The HRO-500, however, employs an internally phase-locked crystal synthesizer to produce the discrete crystal-stable signals required to convert incoming signals in the five KC-30 Mc. range to the tunable IF range of 3.25 Mc.-2.75 Mc. A total of 52 signals between 7.25 and 32.75 Mc are generated from the output of a single, highly stable master crystal oscillator. An up-conversion mixer is used to convert all signals below 4 Mc. to 26 Mc. plus the signal frequency in order to eliminate "holes" in the coverage of the HRO-500 at the various IF frequencies. The drawbacks of multiple crystal oscillators are thereby eliminated, and an extraordinary frequency range of five KC to 30 Mc. in sixty 500-KC bands is achieved because of the ease of HFO signal generation. Operation of the HRO-500 synthesizer is simple and positive. The digital *megacycles* display in the horizontal synthesizer window over the circular *kilocycles* dial changes in 500-KC increments as the *synthesizer tune* control is rotated. The output of the receiver is muted and the *phase lock* lamp flashes between 500-KC points to indicate loss of phase lock. As the desired 500-KC *megacycles* increment comes up in the window, the receiver un-mutes and the *phase lock* lamp extinguishes. Synthesizer tuning is not critical and phase lock range is sufficient to allow substantial movement of the *synthesizer tune* control at any 500-KC lock point without affecting receiver stability or losing phase lock.

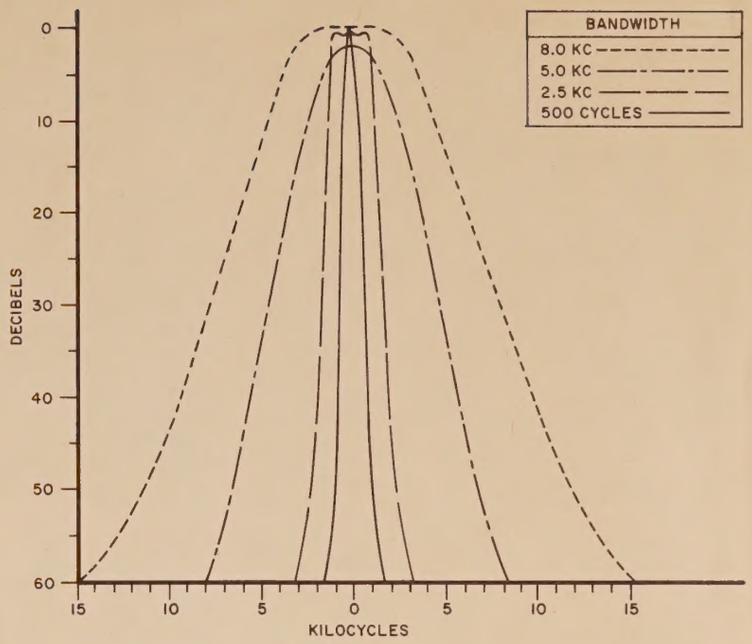
The frequency in kilocycles appearing on the circular VFO main tuning dial is then added to the frequency in megacycles appearing in the synthesizer window to determine frequency within one kilocycle over the tuning range of the receiver.



Shown is the HRO-500 receiver installed in the RMK-5 rack mount kit. Front panel measurements of the RMK-5 are 8¾″ H x 19″ W, and all mechanical dimensions are to Mil-Std. 189. Standard Mil-Spec chassis slides may be installed, if desired, in the field. RMK-5 finish is gray-blue wrinkle enamel with matte black handles.



This view of the HRO-500 receiver (with cabinet removed) shows the unusually neat and straightforward layout of component parts, as well as the rugged chassis and panel construction. The panel is a solid aluminum extrusion which is etched and anodized for maximum resistance to wear. Along the rear apron of the receiver are the 117/234 V.A.C. — 12 V.D.C. selector switch, A.C. and D.C. input power connectors, the multi-terminal socket for auxiliary outputs and remote control, I.F. and oscillator outputs, and HF and LF antenna input connectors.



I. F. SELECTIVITY

I.F. selectivity in the National HRO-500 is obtained by means of a *tunable* six-pole LC type filter. The use of LC components in the filter permits discrete selection of four bandwidths (500 cps, 2.5 Kc, 5.0 Kc, and 8.0 Kc) to meet any SSB, CW, FSK, or AM receiving requirement. The nominal 6-60 db shape factor in the 2.5 Kc bandwidth is 2.5:1.

The HRO-500 is the only general coverage receiver available with a tunable filter which permits *Passband Tuning* in the 500 cps and 2.5 Kc bandwidths. By means of a front panel PASSBAND TUNE control, the filter may be moved across the I.F. passband (while maintaining its shape factor) for true selectable sideband, FSK, or single signal CW reception. The 230 Kc BFO is crystal-controlled at all times, so that proper placement of the filter with respect to the desired signal may always be performed with the PASSBAND TUNE control alone, eliminating frequency shift, changes in beat note, or reduction in intelligibility of an SSB signal.

DYNAMIC RANGE

30% modulated desired signal frequency	Separation in Kc of undesired 30% modulated signal to produce crossmodulation 10 db below desired signal level.	
50 uv	50,000 uv	500,000 uv
1 Mc.	58 Kc	118 Kc
2.3 Mc.	40 Kc	92 Kc
7.0 Mc.	42 Kc	150 Kc
15.0 Mc.	74 Kc	456 Kc

Data is an average of a number of units which includes both high frequency and low frequency sides of desired signal.

The dynamic range characteristics of the HRO-500 are superior to many highly regarded vacuum tube receivers of equivalent sensitivity. The remarkably high performance of the HRO-500 in this respect has been achieved by means of *three* tuned circuits in the RF stage, high selectivity immediately after the first mixer, use of silicon transistors to allow higher injection voltages, and a low noise front end to provide high sensitivity without excessive gain.

It should be noted that the above table is based upon operation of the HRO-500 *at full rated sensitivity* with no input attenuation. The excellent cross modulation characteristics of the receiver may be improved to an even greater degree by use of the AGC THRESHOLD control, which provides up to 30 db attenuation of all incoming signals in the antenna circuit.

HRO-500 WITH LF-10 VLF PRESELECTOR

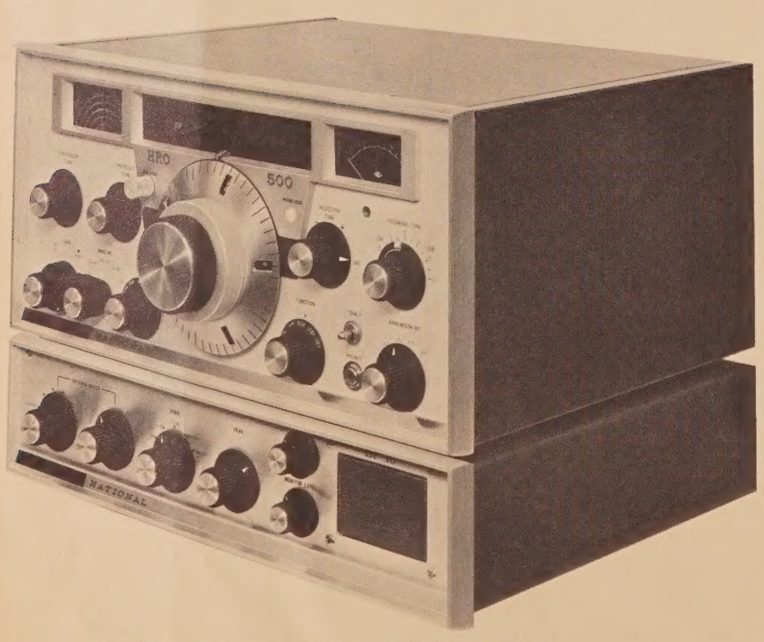
The basic HRO-500 receiver will tune the 5 Kc-500 Kc range in addition to the 500 Kc-30 Mc. range, but with reduced sensitivity and dynamic range. The matching LF-10 preselector, shown above with the HRO-500, provides LF/VLF performance equal to that of the HRO-500 in the HF portion of the spectrum. It is recommended for use in critical laboratory or communications applications.

The LF-10 is delivered ready for either rack or table mounting. Rack mounting flanges with handles are supplied, and may be removed when the LF-10 is table-mounted under the HRO-500 receiver.

Antenna matching controls are incorporated in the LF-10 to permit use of random length antennas as well as 50 ohm feed lines, and antenna switching circuits are provided to permit use of one antenna for both HF and LF operation or separate antennas if available. Antenna switchover is performed automatically when the LF-10 is in use.

A three-inch monitoring loudspeaker is built into the LF-10 with a separate monitoring audio channel to permit independent monitoring of a line being fed by the receiver output. The monitoring speaker and its audio channel may be used, if desired, in place of a separate loudspeaker in both LF and HF operation.

Provisions for an audio filter are also incorporated in the LF-10. A filter channel with its own level control is provided to permit installation of readily available audio filters of any desired frequency and bandwidth to be plugged into a socket provided in the LF-10. The optional audio filter, if used, will operate on both LF and HF frequency ranges of the HRO-500, and may be controlled from the front panel of the LF-10. In addition, filter output may be mixed with normal audio output to provide any desired degree of audio selectivity.



HRO-500 with LF-10 VLF Preselector

LF-10 SPECIFICATIONS:

CONTROLS: ANTENNA MATCH (2); BAND; SIGNAL PEAK; MONITOR LEVEL; FILTER LEVEL.

REAR PANEL CONNECTIONS: Power (to HRO-500); HF Ant. Input; LF Ant. Input; HF Ant. Output; LF Ant. Output; LF Output.

FREQUENCY RANGE: 5 Kc-500 Kc in 4 bands.

SENSITIVITY: AM (nominal) better than 2.0 uv for 10 db S/N; SSB/CW (nominal) better than 1.0 uv for 10 db S/N.

SPURIOUS AND IMAGE RESPONSES: better than 70 db down on all bands.

I.F. REJECTION: 230 KC, 80-115 db; 2.75-3.25 MC., 70-85 db; 26 MC., 100 db.
Internally generated spurious signals: all less than 1.0 μv signal equivalent except for two discrete responses at 0.0 KC and 115 KC.

INPUT IMPEDANCE: 50 ohms to high impedance, adjustable.

MONITORING CHANNEL AUDIO OUTPUT: 1.5 watts maximum.

AUDIO FILTER (NOT PROVIDED): UTC type TGT or TGR with 7-pin base. We recommend that the optional filter be separately purchased from local distributor stock.

POWER REQUIREMENTS: Obtained from HRO-500 receiver.

DIMENSIONS: Table Mount: 3½″ H x 16½″ W x 12¾″ D.
Rack Mount; 3½″ H x 19″ W x 12¾″ D.

WEIGHT: 12 lbs.

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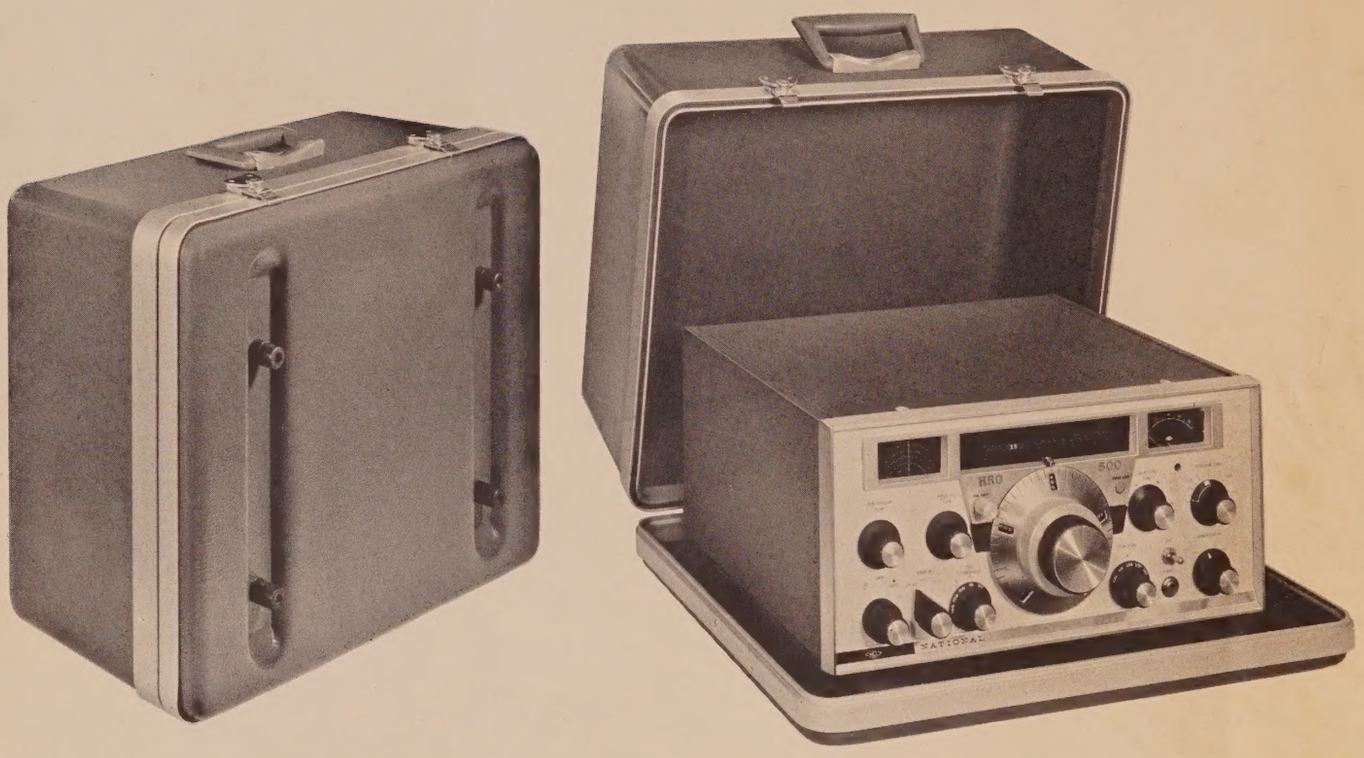
HRO-500P

SELF-CONTAINED FULLY PORTABLE RECEIVING SYSTEM



The HRO-500P is shown installed in its luggage-styled waterproof carrying case. Case materials are high-impact plastic and fiberglass. The case cover may be completely removed by means of quick-release hinges. The rechargeable battery and side mounted speaker are built into the HRO-500P cabinet, so that total field set-up consists of antenna connection.

The HRO-500 receiver may be used for portable or field applications barred to conventional vacuum tube equipment. Because of its light weight, small size, and minimal power requirements, the HRO-500 in a fully portable configuration allows easy transit into the field with rapid set-up to permit on-the-spot monitoring, detection, or measurement with all of the performance previously available only in fixed-station installations.

The HRO-500P consists of the HRO-500 receiver installed in a waterproof luggage type carrying case. The HRO-500P, unlike the standard HRO-500 receiver, incorporates a built-in side-mounted monitoring speaker and a rechargeable nickel cadmium battery. The HRO-500P may be operated from external 12 V.D.C. sources, its own self-contained rechargeable battery, or from 117/234 V.A.C. 50-60 cps supplies.

Since power and speaker are self-contained, total field set-up of the HRO-500P consists solely of removal of the carrying case cover and connection of the antenna.

The HRO-500P is the ideal choice for mobile or field monitoring, intercept work, quick-transit instrumentation, or any portable application demanding rapid set-up with fixed-station performance.

HRO-500P SPECIFICATIONS:

CARRYING CASE DIMENSIONS: 20″ long x 16⅛″ wide x 9″ high.

TOTAL WEIGHT WITH RECEIVER INSTALLED: 49 lbs.

SELF-CONTAINED BATTERY LIFE: 8 hours at 50 milliwatt audio output from receiver with dial lamps extinguished.

OTHER USABLE POWER SOURCES: External 12 V.D.C., 117/234 V.A.C. 50-60 cps.

BUILT-IN SPEAKER: 3″ x 5″ permanent magnet type; side mounted in receiver cabinet. Separate external speaker and/or headphones may also be used.

NOTE: The WPC-5 waterproof carrying case and the rechargeable battery pack are available as separate accessories for the HRO-500 receiver.

SPECIFICATIONS

HRO-500 SPECIFICATIONS

FREQUENCY RANGE: Five kilocycles to 30 Mc. in sixty 500 Kc bands, continuous coverage.
MODES: Selectable upper or lower sideband, MCW, FSK, AM, CW.
POWER REQUIREMENTS:
A. Pilot lamps switched off
   1. 117/234 V.A.C. 50-60 cps; 10 watts at 50 mw audio output, 15 watts at 1.5 watts audio output.
   2. 12.6 V.D.C.; 2.5 watts (200 ma.) at 50 mw audio output, 6.5 watts (525 ma.) at 1.5 watts audio output.
B. Pilot lamps switched on
   1. 117/234 V.A.C. requires additional 7 watts
   2. 12.6 V.D.C. requires additional 590 ma.

CALIBRATION ACCURACY: Within one Kc per 500 Kc band.
SYNTHESIZER ACCURACY: Within 250 cps over entire tuning range when zeroed at 10 Mc.
RESET ACCURACY (Including Visual Error): Within 250 cps.
TUNING DIAL BACKLASH: Less than 50 cps.
TUNABILITY: Within 2 cps.
MAIN TUNING RATIO: Two-speed; 50 Kc/revolution (flywheel) or 10 Kc/revolution.
MAIN TUNING BANDSPREAD: ¼″ per kilocycle; 12 feet per 500 Kc band.
CALIBRATOR: 50 Kc crystal controlled.
FREQUENCY STABILITY (Nominal):
A. In room ambients: 300 cps per hour from point of turn-on to two hours after turn-on; better than 100 cps per day thereafter.
B. With respect to temperature: 15 cps per °C.
C. With respect to A.C. supply variation: essentially none for ±27% change.

R.F. INPUT IMPEDANCE: 50 ohm unbalanced (nominal); also separate high impedance unbalanced input for use with random antennas.
SENSITIVITY (500 Kc-30 Mc):
A. AM (Nominal): Better than 2.0 uv for 10 db S/N.
B. SSB/CW (Nominal): Better than 1.0 uv for 10 db S/N.

SENSITIVITY (Five Kc-500 Kc): 25-200 uv for 10 db S/N without LF-10 preselector; equal to HF sensitivity when LF-10 preselector is used.
SELECTIVITY:
A. 6 db bandwidths available; 500 cps; 2.5 Kc; 5.0 Kc; 8.0 Kc.
B. Filter Design: six-pole LC type operating at 230 Kc; tunable through 6 Kc range in 500 cps and 2.5 Kc bandwidths.
C. Filter shape factor (Nominal): 2.5:1 (6-60 db) in 2.5 Kc bandwidth.
D. Audio filtering provisions incorporated in LF-10 preselector.

HETERODYNE REJECTION FACILITIES: 230 Kc bi-filar notch (REJECTION TUNE control) with ±10 Kc range around IF passband; minimum rejection capability of 50 db. Also, PASSBAND TUNE control (of tunable six-pole filter) permits rejection of adjacent channel interference without change in frequency of desired signal.
IMAGE REJECTION (500 Kc-30 Mc.): Averages 80 db; minimum 50 db.
INTERNALLY GENERATED SPURIOUS SIGNALS: Between 500 Kc and 30 Mc, all less than 1.0 μv equivalent except for two discrete high-amplitude responses at 2.75 and 3.0 Mc. A spurious signal between 0.5 μv and 2.0 μv equivalent amplitude may exist at 500 Kc, and spurious signals up to 2.0 μv equivalent may exist at a maximum of 3 of the following frequencies: 2990 Kc, 3240 Kc, 1.0 Mc, 28.5 Mc, or 29.5 Mc.
AGC: Time constant; 60 millisecond attack, 3 sec. delay. AGC merit; average 5 db output change for input increase from 10 to 100,000 uv.
AUDIO FREQUENCY RESPONSE: 100 cps-5500 cps within 6 db.
AUDIO OUTPUT DISTORTION (Nominal): 0.5 watts, 3.2%; 1.0 watts, 4.4%; 2.0 watts, less than 10%.
AUDIO HUM: Better than 60 db below maximum output.
AUDIO OUTPUTS: 3.2 ohms to rear panel and front panel headphone jack; 600 ohms balanced with center tap (ground reference or floating) to rear panel.
REMOTE CONTROL PROVISIONS: R.F. Gain; A.F. Gain; Receiver Mute; BFO On-Off; Power On-Off.
METERING: Front panel meter calibrated in db above 1.0 uv and from 0 to S-9 between no-signal and 40 db above 1.0 uv.
AGC THRESHOLD CONTROL: R.F. input attenuator; 0-30 db in nominal 10 db steps.
FRONT PANEL CONTROLS: SYNTHESIZER TUNE (MC.); PRESELECTOR TUNE; PASSBAND TUNE; REJECTION TUNE; MAIN TUNING (KC); R.F. GAIN; A.F. GAIN; BANDSWITCH; AGC On-Off-Threshold Control (to 30 db); FUNCTION Off-Standby-SSB-AM-Calibrate; DIAL LAMPS On-Off; BANDWIDTH 500 cps-2.5 Kc-5.0 Kc-8.0 Kc; DIAL LOCK; PHASE LOCK Warning.
REAR PANEL CONTROLS: S-Meter Zero; Rejection Tune Balance; 117/234 V.A.C.-12.6 V.D.C. Selector Switch.
REAR PANEL OUTPUTS: BFO (230 Kc, 47 ohm, 100 mv); VFO (2980-3480 Kc, 100 ohm, 100 mv); synthesizer (500 Kc increments between 7.25 Mc. and 32.75 Mc., 330 ohm, 100 mv); 26 Mc. oscillator (50 ohm, 100 mv): I.F. (50 ohm, output dependent upon signal level); detector (10,000 ohm, output dependent upon signal level); audio; two spare connectors.
REAR PANEL INPUTS: 50 ohm unbalanced H.F. antenna; high impedance unbalanced H.F. antenna; low frequency; 117/234 V.A.C.; 12.6 V.D.C.; sidetone oscillator or external audio.
REAR PANEL VOLTAGE OUTPUTS: +12 V.D.C., +11 V.D.C., +10 V.D.C., +7.5 V.D.C. regulated, +5 V.D.C. regulated, +1.5 V NPN A.G.C., +9 V PNP A.G.C.
ENVIRONMENTAL CONDITIONS:
A. Ambient operating temperatures: −20° C to +45° C.
B. Humidity: to 90%.

MTBF: 3820 hours per NAVSHIPS 93820.
SEMICONDUCTOR COMPLEMENT: 37 Transistors, 21 Diodes.
SIZE: 7⅝″ H, 16½″ W, 12¾″ D.
WEIGHT: 32 pounds.
ALTERNATE CONFIGURATIONS: RMK-5 rack mounting kit for HRO-500 installation (per Mil-Std. 189) in 8¾″ H x 19″ W rack space; HRO-500P portable version with built-in loudspeaker, self-contained rechargeable battery power, and waterproof carrying case.
ACCESSORIES: LF-10 (five Kc-500 Kc preselector); HRO-500-TS matching table speaker (7⅝″ H x 5 29/32″ W x 12¾″ D); WPC-5 waterproof carrying case.

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NOTE: ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.